

## **METHOD AND APPARATUS SUITABLE FOR DEMAND FORECASTING**

### **Field of the Invention**

This invention relates to method and apparatus suitable for demand forecasting, for example, by way of item, attribute, and location.

### **Background of the Invention**

Our work on demand forecasting considers the following illustrative construct.

Contemplate a situation wherein seasonal or fashion items are sold for a finite season. The "item" considered here can be a fine line, a style, or even a style color. The items typically are not replenished during the season, and are sold in kind across seasons.

One important demand forecasting objective, informed by this situation, is to generate a sales forecast "by item, by size, by location." This sales forecast, in turn, can then be used advantageously to drive decisions on buying, allocation, markdowns and promotions.

## **Summary of the Invention**

One important goal of the present invention is to provide novel methodology and apparatus which can realize the just-cited demand forecasting objective. To this end, we first summarize two types of difficulties or problems that are adumbrated and resolved as an included, subsumed feature of the novel method and apparatus.

The first type of difficulty centers on a problem of "contaminated data". Here, observed data may be the result of a mixture of factors - inherent demand, seasonality, promotions, markdown, in-stock or not. We note that future forecasts need to be a function of the major controllable factors.

The second type of difficulty centers on a problem of sparse data. Data may be sparse for two reasons. First, many if not most items in a store are not high volume sellers, resulting in few positive sales when measured in typical planning time buckets such as weeks. Second, the number of combinations of factors affecting sales (e.g., item, size, location, seasonality, markdown, promotion) is large. Together with the relatively short history (one or two seasons) that is appropriate for seasonal/fashion items, the number of data points per confirmation of factors, is small.

We have now discovered novel methodology and apparatus which can realize the demand forecasting objective of generating a sales forecast "by item, by size, by location". As an included advantageous feature, the novel method and apparatus addresses and resolves problems relating to contaminated and/or sparse data.

The present invention in a first aspect comprises a novel method suitable for projecting demand, the method including the steps of:

- (i) identifying a first set of merchandise;
  - (ii) specifying a second set of merchandise which is to be used as a referent for soliciting information relative to demand behavior for a pre-determined attribute of said first set of merchandise;
  - (iii) clustering the second set of merchandise for generating a demand profile for said pre-determined attribute of said first set of merchandise;
  - (iv) clustering the second set of merchandise for generating a demand model correlated to model-based demand attributes of said first set of merchandise;
- and
- (v) combining the step (iii) demand profile and the step (iv) demand model into a single encompassing model which is capable of projecting demand of the first set of merchandise.

With reference to this statement of the invention as genus, we now set forth preferred particular features of the invention.

The first and second sets of merchandise may be disparate, but typically and preferably comprise overlapping sets of merchandise.

The step of selecting the pre-determined attribute of said first set of merchandise is advantageously realized by selecting from a group consisting of items, size, and location; or, selection, from a group consisting of items, size, color, and location.

Step (iv) preferably comprises generating a demand model based on modeling demand as a function of major variables selected from a group consisting of price, promotions, inventory level, and seasonal objects.

Step (v) preferably comprises combining the demand profile and the demand model into a single encompassing model by apportioning the model-based demand forecasts, to the appropriate size distribution, using a size demand profile.

The present invention in a second aspect comprises a computer operated method for projecting demand, including the steps of:

- (i) identifying in a database a first set of merchandise and a

second set of merchandise which is to be used as a referent for soliciting information relative to demand behavior for a pre-determined attribute of said first set of merchandise;

(ii) employing a processor for:

(a) clustering the second set of merchandise for generating a demand profile for said pre-determined attribute of said first set of merchandise;

(b) clustering the second set of merchandise for generating a demand model correlated to model-based demand attributes of said first set of merchandise;

and

(c) combining the demand profile and the demand model into a single encompassing model which is capable of projecting demand of the first set of merchandise;

and

(iii) displaying the demand forecasts by the pre-determined attribute.

The present invention in a third aspect comprises a computer suitable for projecting demand, the computer including:

(i) a database comprising an identified first set of merchandise;

(ii) a database comprising an identified second set of merchandise which is to be used as a referent for soliciting information relative to demand behavior for a pre-determined attribute of said first set of merchandise;

(iii) a CPU receiving inputs from the database and comprising means for:

(a) clustering the second set of merchandise for generating a demand profile for said pre-determined attribute of said first set of merchandise;

(b) clustering the second set of merchandise for generating a demand model correlated to model-based demand attributes of said first set of merchandise;

(c) combining the demand profile and the model into a single encompassing model which is capable of projecting demand of the first set of merchandise;

and

- (iv) an output display for showing the demand forecasts by the pre-determined attribute.

### **BRIEF DESCRIPTION OF THE DRAWING**

The invention is illustrated in the accompanying drawing, in which Figure 1 shows an Outline of a Forecasting Process developed in accordance with principles of the present invention.

### **DETAILED DESCRIPTION OF THE INVENTION**

The detailed description of the invention unfolds by first setting forth, in a list format, desiderata pertinent to "Item Forecasting" and then "Size Profile Projection", and then secondly presenting an Example of the invention. Reference should be made to FIG. 1, (numerals 10 - 20), which provides an overview of the invention.

#### **1) Item Forecasting.**

The Item Forecasting component provides methods to project sales for a selected set of merchandise during pre-season planning or in-season re-planning/monitoring.

The main features of the forecasting model are:

- a. It can handle relatively short history, such as those of new fashion items.

- b. It can take into account selling price and promotional activities throughout the season.
- c. Provided enough history, it can estimate a trend if present in the data.
- d. It can handle the above mentioned causal and time series factors in an integrated manner.

**Approach:**

- i. Basic analysis per season or year. Cluster sales data by seasonality and price/promotion elasticity's using model-based clustering.
- ii. During the season, update parameters (base sales, seasonalities, and price/promotion elasticities) using dynamic modeling and the initial parameter values from the basic analysis. If the product is a new class to the retailer and there is no "similar" historical data, the user can specify initial parameter values based on their expert knowledge.
- iii. Sales forecasts by cluster can be computed using the most updated parameters. Forecasts per sku (including size) can be computed by apportioning the above forecast.

**2) Size Profile Projection.**

The main function here is to project a size profile for apparel items per store so that merchandise can be purchased accordingly. Size Profile Projection may be achieved as follows:

A periodic analysis of recent historical sales data to obtain a basic size profile per store.

Data from replenishable as well as seasonal items are useful. This can be performed once a year or once every season.

**Approach:**



i. Estimation of lost sales to complete sales data by size.

ii. Cluster sales data by mean sales per size per time period using e.g.,  
k-mean method.

We now illustrate the details of this invention by way of an Example.

Assume we are given a task to forecast, by size and location, a demand for women's swimsuits manufactured by a certain manufacturer. This is the first set of merchandise (e.g. as in claim 1 step i).

We are given last season's sales figures for this particular item, by location and size. At this detail level, weekly sales are sparse on the average. Furthermore, these sales are also affected by seasonality effects, promotions, markdowns, and inventory levels. In order to overcome the sparsity problem, we select, as a second set of merchandise, the first set of merchandise, and in addition, swimsuits from other manufacturers, as well as other fashion items such as women's dresses, shoes, and sweaters. This corresponds to e.g., claim 1 step ii.

We now run a clustering algorithm such as the K-Means algorithm, the Kohonen network algorithm, the Learning Vector Quantization algorithm, or equivalent, which partitions the second set of merchandise into clusters with "similar" size profiles (for each location and each period, e.g., week). Similarity here, simply means that all members of a cluster have an identical size

distribution, or very close to it. This corresponds to e.g., claim 1 step iii and addresses the data sparsity problem.

To address the effects of other variables on demand profiles, we perform a model-based clustering procedure on the same second set of merchandise. This model includes seasonal indices, markdowns, promotions and inventory levels. It partitions the second set of merchandise into clusters with "similar" profiles for these variables. Here, similarity means that all members of a cluster have identical (or almost identical) seasonal indices, markdown and promotion sensitivities, as well as inventory effects. This corresponds to claim 1 step iv. Details of this last procedure are preferably given in copending and commonly assigned U.S. patent application Serial No. \_\_\_\_\_, the disclosure of which is incorporated herein by reference.

At this point we can forecast demand by location and size by first performing the model-based forecasts which considers seasonality, pricing, promotion, and inventory levels, and the apportioning of these forecasts by location and size, using the clustered size profiles. This corresponds to e.g., claim 1 step v.

In a preferred embodiment, the clustering and modeling are performed once, at the beginning of a sale season, at which time an initial demand distribution, by location and size, is computed. As new data become available, demand projections get updated dynamically.